Electronic Services - Los Angeles
M10390X

instruction manual

BECKMAN/BERKELEY
INTERVAL TIMER

Model 5601-50 CONTROL UNIT
Model 5620-3 READOUT UNIT

Beckman®
Berkeley Division

BECKMAN/BERKELEY
INTERVAL TIMER

Model 5601-50 CONTROL UNIT
Model 5620-3 READOUT UNIT

J. O. _____

Serial No. _____

BERKELEY DIVISION
BECKMAN INSTRUMENTS, INC.

Richmond 3, Calif.
22 August 1958

BECKMAN/BERKELEY
INTERVAL TIMER

Model 5601-50 Control Unit
Model 5620-3 Readout Unit

General

The Berkeley Models 5601-50 and 5620-3 Interval Timer is a special unit built for Douglas Aircraft Company to be used in conjunction with Model DM-14 test equipment. The electrical specifications for the Timer are as set forth in Douglas Drawing No. 7600828 and are as follows:

Range:	.001 second to 9.999 seconds in increments of 1 millisecond
Accuracy:	±1 millisecond
Oscillator:	100KC ±1 cycle
Sensitivity:	Start Event - 100 volt negative pulse Stop Event - 100 volt positive pulse

Operation

The instrument is made up of several plug-in units to facilitate servicing. The control chassis consists of a power supply and circuitry to interconnect the plug-in units and the remote four decade readout. The Model 5632-3 A Oscillator and shaper and the Model 705A Decimal Counting Units are covered in the appendices in the rear of this manual. The heart of the control unit is the Model 5657-1 Gate Control Plug-In which contains the Start, Stop and Signal Gates, plus the input circuitry and Control Binary.

The sequence of operation is as follows:

Assuming the external reset button has been depressed, all the decades in the remote indicator have been cleared to zero and the Control Binary has assumed a condition such that the Start Gate is open, and the Stop and Signal Gates are closed. Upon receipt of the first start pulse, the Control Binary is flipped to its opposite state causing the Start Gate to close and the Signal Gate to open. The Signal Gate allows the 1 KC clock pulses to drive the remote indicator and the timing begins. Also, the Stop Gate has been opened at this time. Upon receipt of a stop pulse, the Control Binary flips back to its original state which closes the Signal Gate and the Stop Gate and opens the Start Gate to ready the unit for the

next start pulse. The remote indicator will display the time in milliseconds between the start and stop events and will hold this result until the next start event or until the unit is reset externally. The start event also resets the remote decades to zero before timing begins.

Theory

Refer to Drawing No. 9118C15. The three gate tubes V102, V104 and V106 are 6AS6 pentodes whose signal grids are biased off. Positive pulses are impressed upon the control grids. During the period their suppressor grids are at ground or above, the tubes will amplify the grid signal. In this state the Gates are "open". When the suppressor grids are below -10 volts, the tubes are cut off and Gates may be considered "closed".

The "open-close" voltages on the Start Gate V102 tube suppressor grid are generated at the right plate of the Control Binary V103. V103 is a conventional "flip-flop" circuit. Such a circuit has two stable states: left hand conducting, right half cut off; and right half conducting, left half cut off. A negative transient applied to the junction of R115 and R116 will flip the binary from one state to the other.

The negative start pulses are impressed upon pin 7, V101 which is a cathode follower providing 10 megohm input impedance. The diode CR101 and the integrating network consisting of R105 and C101 allow only negative pulses to be applied to pin 2, V101. This network is essential since a large positive transient is developed during the time the Start Gate is opened which would disrupt the operation.

The right half of V101 inverts the start pulse and the resulting positive pulse is impressed upon the control grid of Start Gate V102. When the Control Binary is flipped, the resulting positive pulse is coupled through C104 from the left half of V103 to pin 7. V105. The action of cathode follower V105 resets all the decades to zero. CR102 prevents the pulse from resetting the Control Binary, but allows the binary to be reset through the action of the left half of V105.

The "open-close" voltages on the Stop and Signal Gates V106 and V104 are taken from the left plate of the Control Binary V103 and impressed upon their suppressor grids. The Stop pulses are impressed directly to the control grid of V106 through C111. The 1 KC clock pulses are impressed upon the control grid of the Signal Gate V104 through C109.

Refer to Drawing No. 20696C301. The 100 KC pulse from the output of the Model 5632-3 drives the 705A DCU AY102 which in turn drives AY103, 705A DCU to derive a division of 100 to produce 1 KC clock pulses.

The power supply is conventional full wave choke input filtered to provide +320 volts. This voltage is dripped through R104 to fire the gas tube V103 to produce a stabilized supply of +150 volts. The bias supply is

rectified by V102 and filtered through C104, R106 and C105 to derive -250 volts. CR101 forms a full wave bridge to provide 115 volts DC to supply the external fan.

Refer to Drawing No. 9118B23. This is the schematic for the four decades in the remote indicator which is self explanatory. Complete information for the Model 705A DCU is found under Appendix A.

INSTRUCTION
MANUAL

Appendix A
Lot 36 and up

Model 705AF
DECIMAL COUNTING UNIT

BERKELEY division of
Beckman Instruments, Inc.

Richmond 4, California
15 December 1953

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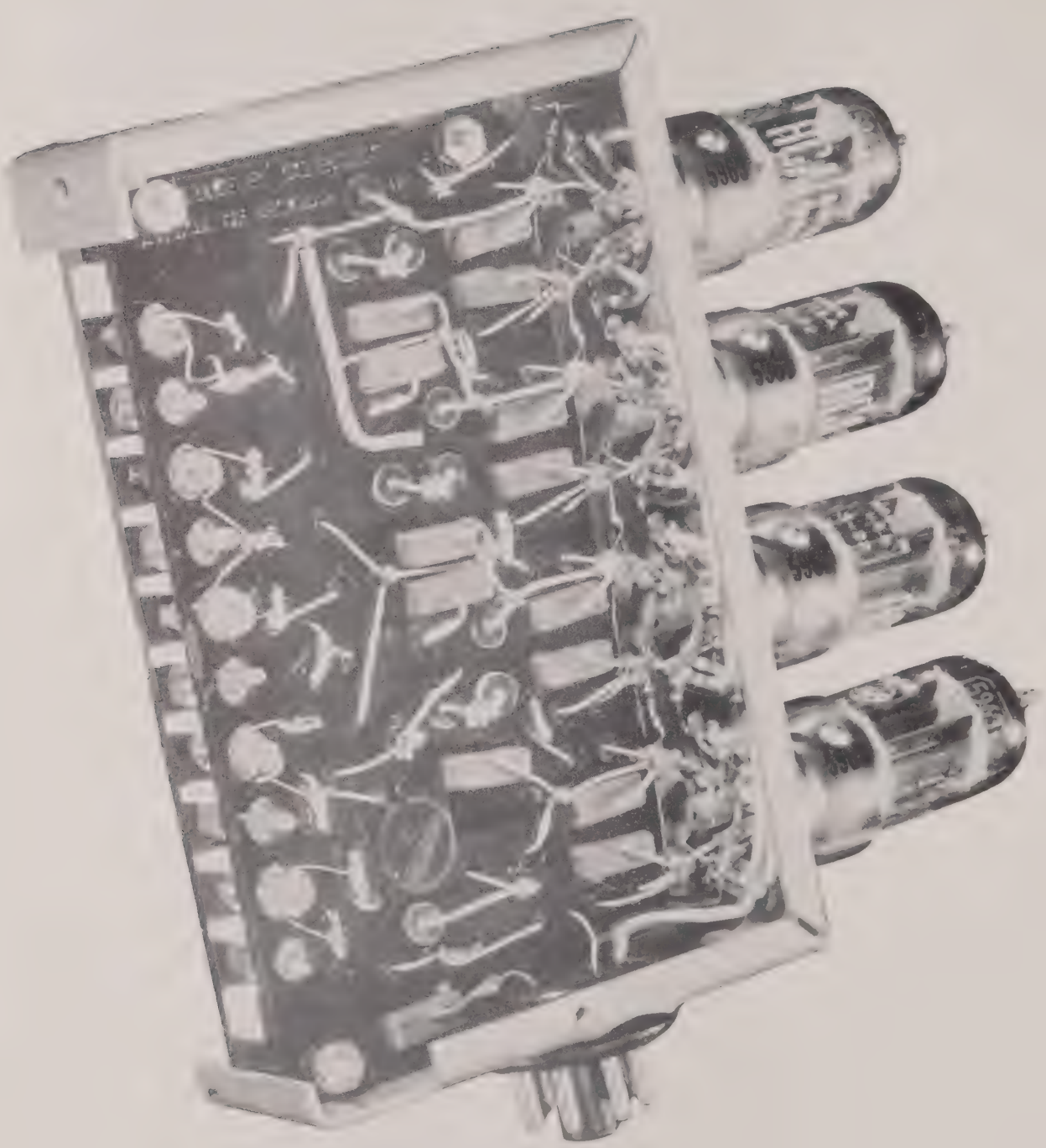


Figure 1 Model 705AF Decimal Counting Unit

Section 1
INTRODUCTION

The Model 705AF Decimal Counting Unit is a direct-reading, plug-in electronic counter with facilities for extracting information from the DCU to operate other electronic devices. The number of counts received is indicated by the illumination of one of ten neon lamps placed behind a numbered acetate panel. Each unit counts from zero to nine, the tenth pulse resetting the counter to zero and simultaneously generating an output signal. any number of these units can be connected in cascade (the output of one unit driving the next), forming a counter whose total count capacity depends only on the number of DCU's. Thus, five units will count to 99, 999 resetting to 00, 000 on the 100, 000th pulse (see Figure 1).

Specifications

Count Indication	Direct reading Decimal presentation
Power Requirements	Heater: 6.3 v. at 1.2 amps. Plates: 300 v. at 15 ma.
Input Requirements, recommended	Negative pulse 100 v. peak amplitude
Rise Time	Less than 1 μsecond
Duration	At least 2 μseconds
Output Characteristics*	Designed to drive Model 705A or 705AF
Resolution of Paired Pulses	5 μseconds
Reset to Zero	Instantaneous through opening of grid
Maximum Counting Rate	100, 000 cps
Construction	Plug-in unit, 11-pin socket

Output information is also presented at four of the pins on the 11-pin plug as high or low voltages, depending upon the number of counts the DCU has received.

Section 2
OPERATION

Installation

Normally, Decimal Counting Units are installed in Berkeley instruments. No special instructions are necessary. For unusual installations, we invite your inquiry.

The reset pin (pin #3 on the 11-pin plug) should be connected to ground through a normally-closed switch or relay contacts. To reset the unit, open the contacts momentarily. Care must be taken to avoid coupling voltage surges into the input or power supply circuits.

Operation

Power requirements:

Plates:	250 volts to 350 volts (nominal 300 volts at 15 ma)
Filaments:	6.3 volts at 1.2 amperes

Input requirements:

If the unit is powered by an unregulated supply, the drive amplitude should vary with the supply voltage. A negative transient is required to drive the unit, either a square wave or a rectangular pulse at least two microseconds wide. The pulse amplitude depends on the rise time. For a rise time of 0.5 microseconds (measured between ten and ninety percent values), the pulse amplitude should be between 75 and 135 volts; for a two microsecond rise time, an amplitude of 120 to 165 volts should be used. Rise times of one microsecond or less, pulse amplitudes of 100 volts and a 300 volt supply offer optimum performance. The input load presented by either unit during triggering is equivalent to 100 $\mu\mu$f in series with 15,000 ohms.

Output requirements:

The output is a rectangular waveform presented at the output terminal as a change in d-c voltage (see Figure 4). Between "0" and "6", the output is 55 volts; "6" and "7", 125 volts; and "8" and "9", 135 volts. The slip between "7" and "8" is caused by an interpolation network.

The load imposed on the unit must not be more than 300K to ground or 6K in series 100 $\mu\mu$f.

Section 3

THEORY OF OPERATION

Basic Design

The basic circuit of the Model 705AF is a modification of the Eccles-Jordan trigger circuit with two stable states, referred to as a binary. It is a two-stage amplifier with the output of the second stage connected to the input of the first, as shown in Figure 2.

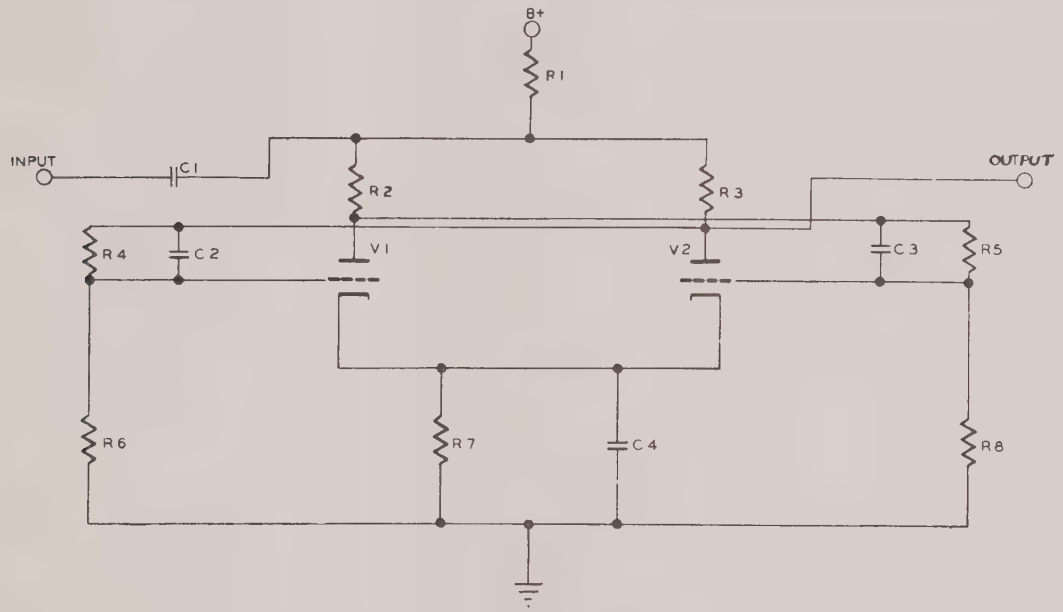


Figure 2, Basic Circuit, Model 705AF

With no input, the loop gain is less than one, and the circuit is in one of its two stable states, i.e., either V2 conducting and V1 cut off, or vice-versa. The circuit is triggered from one state to the other by making the loop gain greater than one. The binary is coupled to a single trigger source through C1 and R1 in such a way that the effect of the trigger is different on the two stages, depending on which stage is conducting. For example, assume that V2 is conducting and V1 is cut off. If a negative pulse is applied to the input, there is a drop in the plate voltage of V1. This drop in voltage is transmitted through a cross-over network (R5, R8, C3 and the grid-to-ground capacitance of V2) and applied to the grid of V2. The plate voltage of V2 then starts to rise, carrying with it the grid of V1. When the input pulse is of sufficient amplitude, the loop gain becomes greater than one, and the binary is triggered to its other stable state, V1 conducting and V2 cut off.

The next input pulse reverses the process and causes the binary to return to its original state. Thus, the binary completes a cycle for every two input triggers and is a scale of 2. By a cascade arrangement of binaries, a counter having a scale of any power of 2 can be obtained.

Circuit Analysis

Four binaries are connected in cascade forming a scale-of-16 which is permuted to a scale-of-10 by two resistor-capacitor "feedback" networks (see Figure 3).

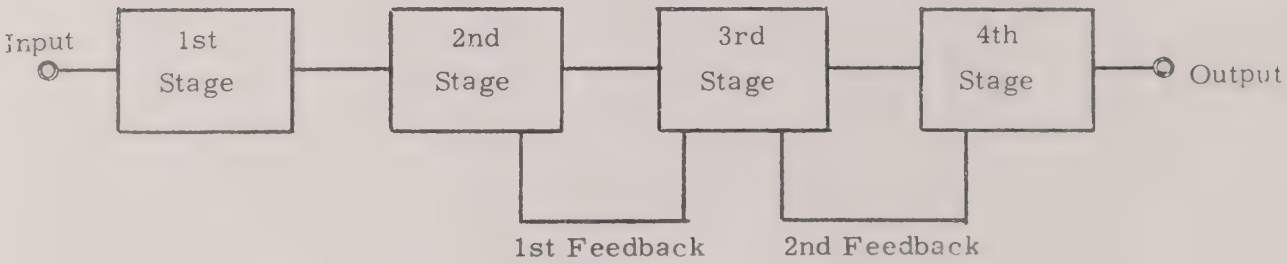


Figure 3, Functional Diagram, Model 705AF

The circuit operates as a conventional binary counter up to the count of four. On the count of four, the third stage is triggered, sending a pulse through the first feedback network, thereby triggering the second stage. Since it requires two inputs to trigger the second stage, this is the equivalent of adding two input pulses and the unit now corresponds to a binary count of six. On the count of six (which is the equivalent of eight in a binary counter) the fourth stage is triggered, sending a pulse through the second "feedback" network and triggering the third stage. This is the same result as if four additional input pulse had been applied and the unit has a binary count of twelve stored in it. The unit again operates as a binary scaler for the remaining four pulses required to reset it to zero. Therefore, by adding the equivalent of six input pulses the scale-of-16 has been permuted into a scale-of-10.

Section 4

MAINTENANCE

When a Decimal Counting Unit is suspected of counting incorrectly, it should be interchanged with another unit in the instrument or replaced with a spare unit to determine whether the trouble is in the suspected unit or in the associated circuitry. This test should be made very carefully. The counting unit is usually the indicating device of an instrument, and is quite often accused of counting incorrectly when the fault is external to it.

Trouble-Shooting

Two methods are recommended for finding the trouble in a faulty counting unit. First, by observing the lighting sequence while driving the unit at a slow repetition rate, and second, by studying the waveform of each stage while driving the unit at a repetition rate fast enough to be conveniently viewed on an oscilloscope. It is impossible to say which method should be used in every case, since marginal failures may occur at high counting speeds and not at lower counting rates, and vice versa. The first method is the only way that a neon lamp failure can be located, and it can be used to locate component and tube failures. For this reason, it is recommended that this method be used first. Table 1 lists common troubles. Remember, tubes are the most frequent cause of failure.

Diagrams and Tables

Figure 4 shows the waveforms for each stage. By comparing these with those of a faulty unit, troubles may be isolated.

Schematic drawings will be found at the rear of the manual. The voltages shown were obtained with a vacuum tube voltmeter, a supply voltage of 300 volts, and measured between ground and the point indicated. The unit must be reset to zero to obtain the values shown.

Table 2 lists the voltages and resistances between tube socket connections and ground so that, in conjunction with the schematics and parts location diagrams, all information necessary to maintain the equipment in proper working order is available. It should be remembered that the values given are nominal, and considerable variations may be encountered owing to various line voltage conditions and component tolerances.

Table 1

COMMON TROUBLES*

SYMPTOM	CAUSE
Unit Fails to Count	(a) Insufficient supply voltage. (b) Input signal of insufficient amplitude. (c) Input signal of wrong polarity. (d) First stage inoperative.
Unit Counts Spuriously	(a) Stray output signal. (b) Pulses received through power supply. (c) External voltages picked up by output lead.
Unit Counts Erratically	(a) Input signal too large or small, incorrect rise time. (b) Supply voltage fluctuating too much.
Unit Fails to Reset	(a) Stray counts from reset switch or associated circuitry. (b) Defective component.
Unit Counts in Wrong Sequence (the pattern of lighting is repeated after a difinite number of input pulses. One or more lights may be "On" simultaneously during a cycle provided that the number of states per cycle remains constant).	
1. Unit skips every other number.	(a) First stage defective. (b) Input circuit supplies double pulses.
2. Two stable stages per cycle.	(a) Second stage defective (count can be 01 or 45). (b) Loss of drive to second stage (01) .
3. Four stable states per cycle.	(a) Third stage defective (count can be 0123 or 6789). (b) Loss of drive to third stage (0123).
4. Six stable states per	(a) Output excessively loaded (count can be 012345-012345). (b) Last stage inoperative (count can be 01234501 etc. or $67^{89}_{23}89$. The count $^{8}_{2}$ indicates both "8" and "2" lamps are on. (c) Loss of drive to fourth stage (count can be 012345).

5. Eight stable states per cycle or any failure where two successive number are skipped.	(a) Second or third stage failure.
6. Ten stable states per cycle, but the lighting sequency is incorrect.	(a) Where the "0" neon lamp lights instead of the "4" the trouble is with either the "0" or "4" lamp, and in the majority of cases it is "4". This can happen on any count; zero and four were used as examples. It is also possible that more than one lamp may light in place of, or with the one that fails.
7. Twelve stable states per cycle.	(a) When lighting sequence is $0123^{01}_{45}456789\text{-}0$, etc. (The count $^{0}_{4}$ indicates both "0" and "4" lamps are on.) First feedback failure. Second or third stage losing emission.
	(b) When the lighting sequence is $01234567^{23}_{89}89\text{-}0$, etc. Second feedback failure. Third or fourth stage losing emission.

*Reset Unit before troubleshooting.

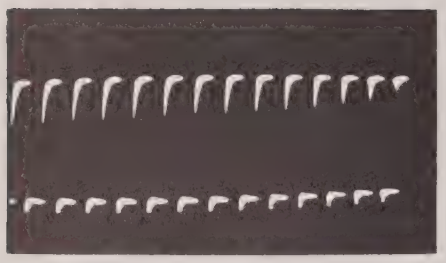
Table 2
VOLTAGES & RESISTANCES

Tube	Pin No.	D.C. Voltage to Ground	Resistance to * Ground (in ohms)
V101	1	170	105K
	2	17	85K
	3, 8	37	12 K
	4, 5, 9	Filaments	
	6	60	105K
	7	37	85K
V102	1	135	93K
	2	15	83K
	3, 8	30	12K
	4, 5, 9	Filaments	
	6	55	93K
	7	30	83K
V103	1	135	100K
	2	15	83K
	3, 8	30	12K
	4, 5, 9	Filaments	
	6	55	100K
	7	30	83K
V104	1	135	93K
	2	15	83K
	3, 8	30	12K
	4, 5, 9	Filaments	
	6	55	93K
	7	30	83K

* When making the above resistance measurements on a DCU with an octal plug, connect Pin 2 to Pin 6. On a DCU with an 11-pin plug connect Pin 3 to Pin 8.

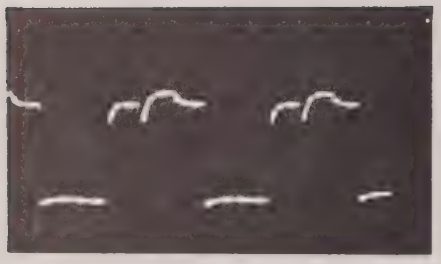
NOTE

The following waveforms were photographed from a Tektronix Model 511D oscilloscope at f4.5 and 1/2 second.



A. First Stage, Pin 6, V101, UVL + 168, LVL + 58, frequency 20Kc.

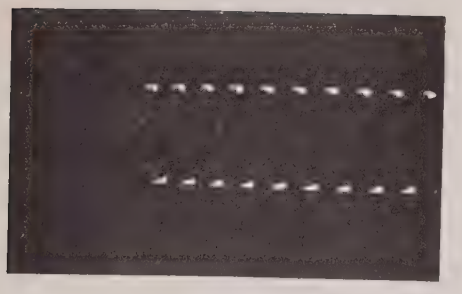
B. Second Stage, Pin 6, V102, UVL + 140, LVL + 55, frequency 20 Kc.



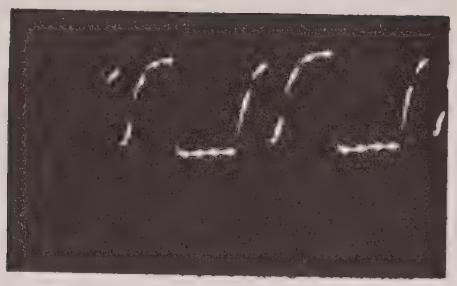
C. Third Stage, Pin 6, V103, UVL + 140, LVL + 55, frequency 20 Kc.

D. Fourth Stage, Pin 6, V104, UVL + 14 , LVL + 55, frequency 20Kc.

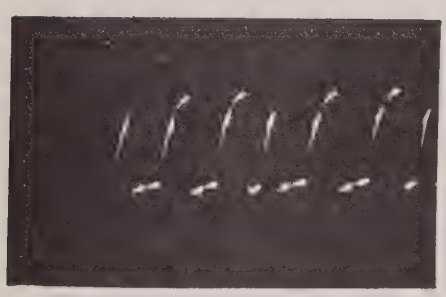
Figure 4 Typical Waveforms



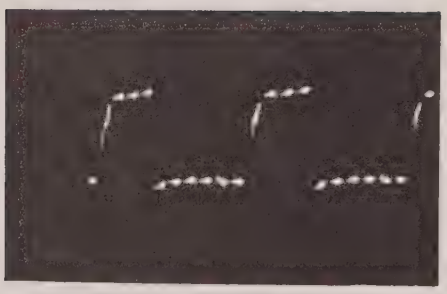
E. First Stage, Pin 6, V101, UVL + 168, LVL + 58, frequency 100Kc.



F. Second Stage, Pin 6, V102, UVL 140, LVL + 55, frequency 100Kc.

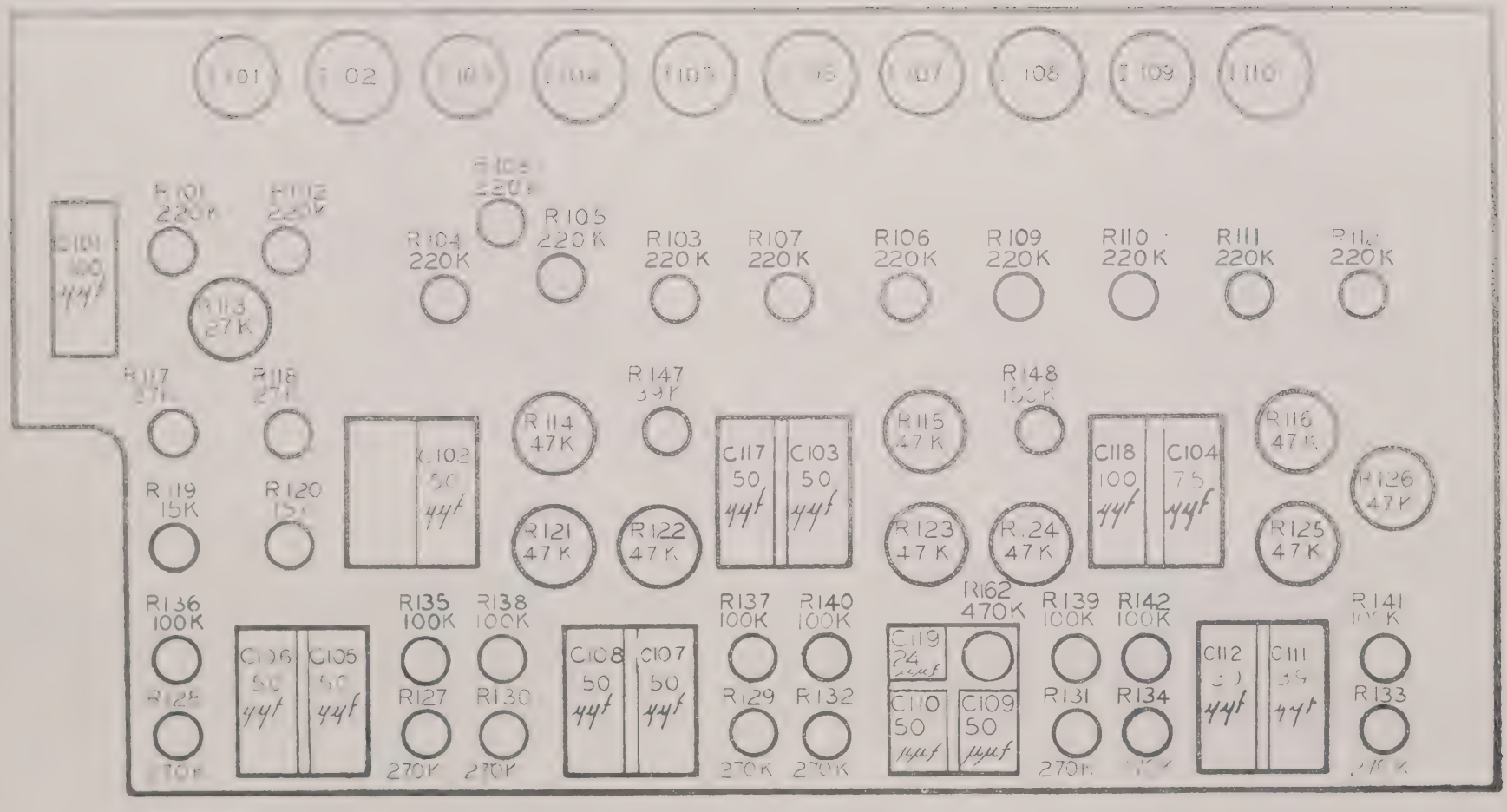


G. Third Stage, Pin 6, V103, UVL + 140, LVL + 55, frequency 100Kc.



H. Fourth Stage, Pin 6, V104, UVL + 140, LVL + 55, frequency 100 Kc.

Note: UVL = upper voltage level
LVL = lower voltage level
All waveforms are blanked.



NOTE:
1. MADE FROM 1233-D-80.

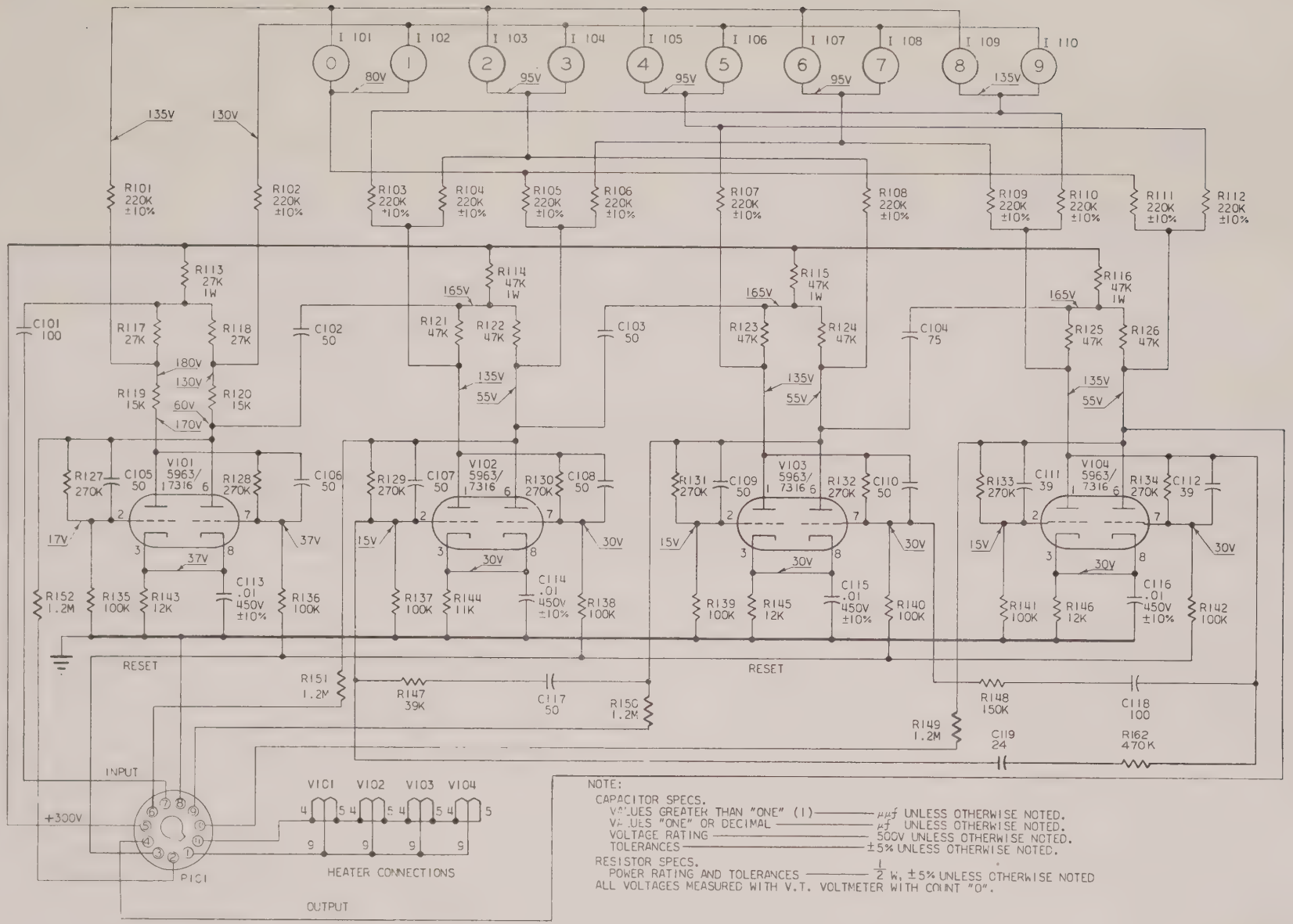
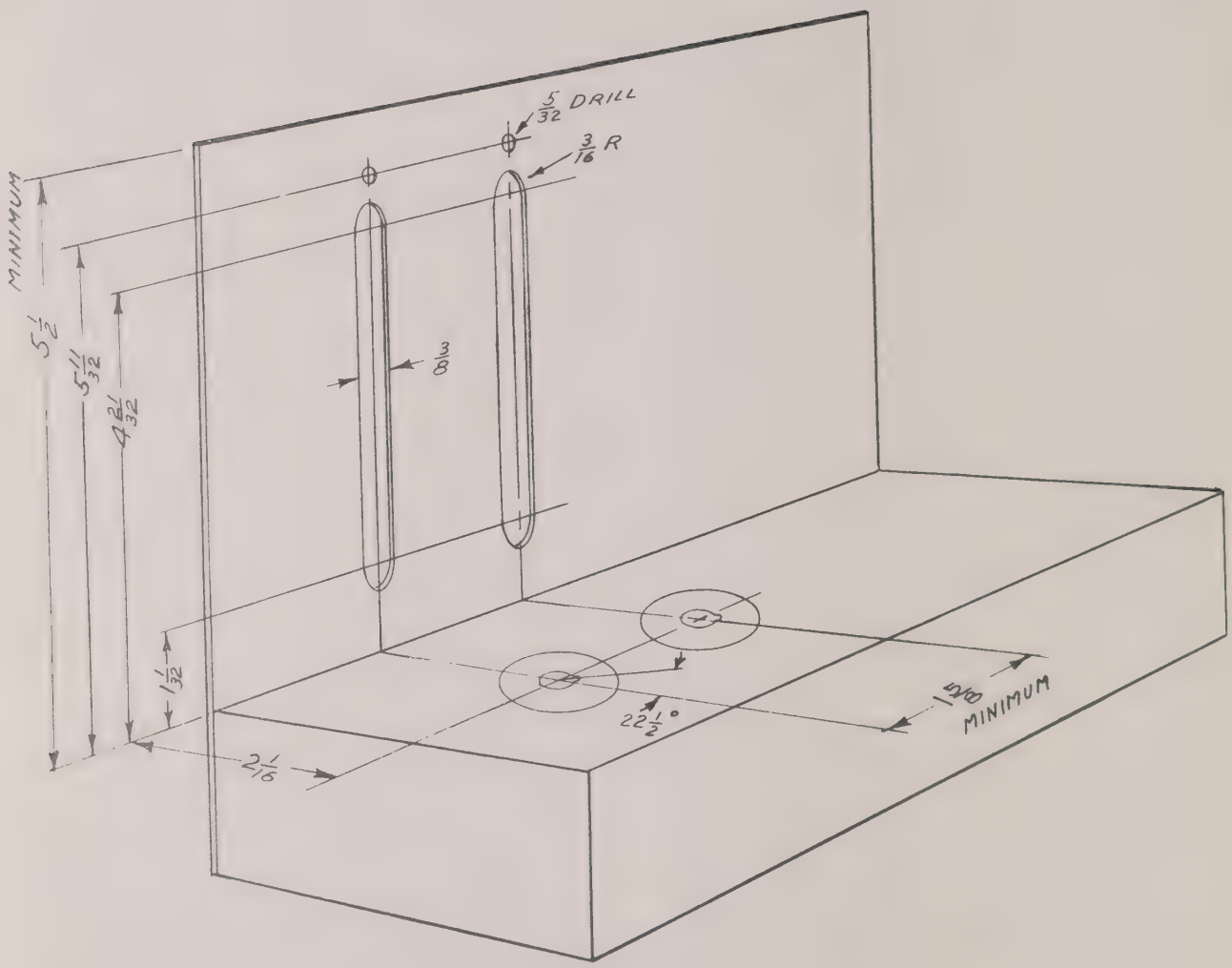


Figure 6 Schematic Diagram, Model 705AF



NOTE: Dimensions are based on the use of an Amphenol "MIP" 8 or 11-pin socket and .064 metal in the chassis.

Mounting Dimensions, Model 705AF

BERKELEY
OSCILLATOR and SHAPER

Model 5632-3

BERKELEY Division
Beckman Instruments, Inc.

Richmond 3, Calif.
6 Sept. 1957

BERKELEY
OSCILLATOR and SHAPER

Model 5632-3

The Berkeley Model 5632-3 Oscillator and Shaper is a plug-in unit containing a 100 kc oscillator and shaper with the proper output to drive a Decimal Counting Unit or other circuitry with a load of not more than 6 K in series with 100 μμf.

The oscillator circuit consists of a two stage amplifier with a series-resonant crystal network feedback loop. This system would oscillate even with the crystal (Y101), its series coil (L102), and capacitors C108 and C109 shorted, because any signal which appears on one of the grids is amplified, inverted and fed in phase so that it reinforces the original signal. The series-resonant crystal network permits only the 100 kc frequency to be effective since a phase shift is introduced at any other frequency. Also L101 and C105 are parallel-resonant only at the required frequency. Figure 1 shows the relationship between the frequency and phase angle of the frequency determining oscillator components. The amplitude is kept constant through bias developed across R103, while the cathode by-pass capacitors, C103 and C104, tend to eliminate degeneration by maintaining the cathode potentials at steady dc values.

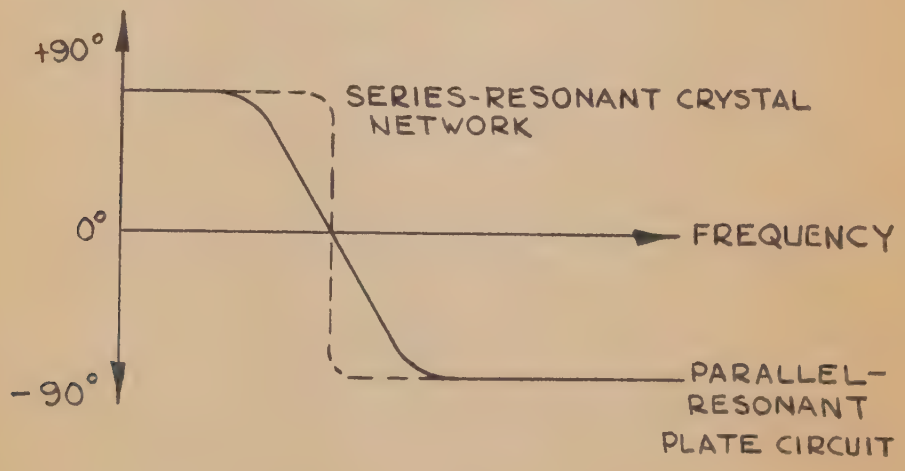


FIG. 1 - OSCILLATOR PHASE-FREQUENCY GRAPH

The net result is that the circuit has zero phase-shift, constant amplitude, and a loop gain of one, which fulfills the requirements for an oscillator at 100 kc. Fine adjustment of the oscillator is obtained with FREQ. ADJ. capacitor with PLATE TUNE capacitor C106.

The shaper circuit transforms the sine-wave output of the oscillator into the rectangular wave needed to drive a DCU. The circuit is essentially a one-shot multivibrator whose R-C coupling has a very long time constant compared to the period of the sinusoidal input. The operation, however, is similar to that of a Schmitt Trigger since the input signal forces the tube to recover long before C111 has a chance to recharge through R114.

R102
270K

1KC E102

10KC E101

270K
R105

E-101
10M

AY101
M5631-3
OSC & SHAPER

AY102
M705A
O.C.U.

AY103
M705A
O.C.U

AY104
M5657H
GATE CONTROL

C101
.001 mfd.
400V

J12
REMOTE INDICATOR
AN3102-18-12S

T101
ELECTRO E-8553

6.3V @ 9A.

5.0K @ 8A.

410V

600V

410V.

6.8V @ 2A.

R103
100Ω

F101
3 AMP.

V101
5U4

V102
6H6

OSBORNE 5701

L101
10HY

R104
9K-10W 10%

+320

+150

V103
0A2

C102
10mfd
600V

C103
10 mfd
600V

C104
1 mfd
600V

R106
12K 2W 10%

C105
1 mfd
400V

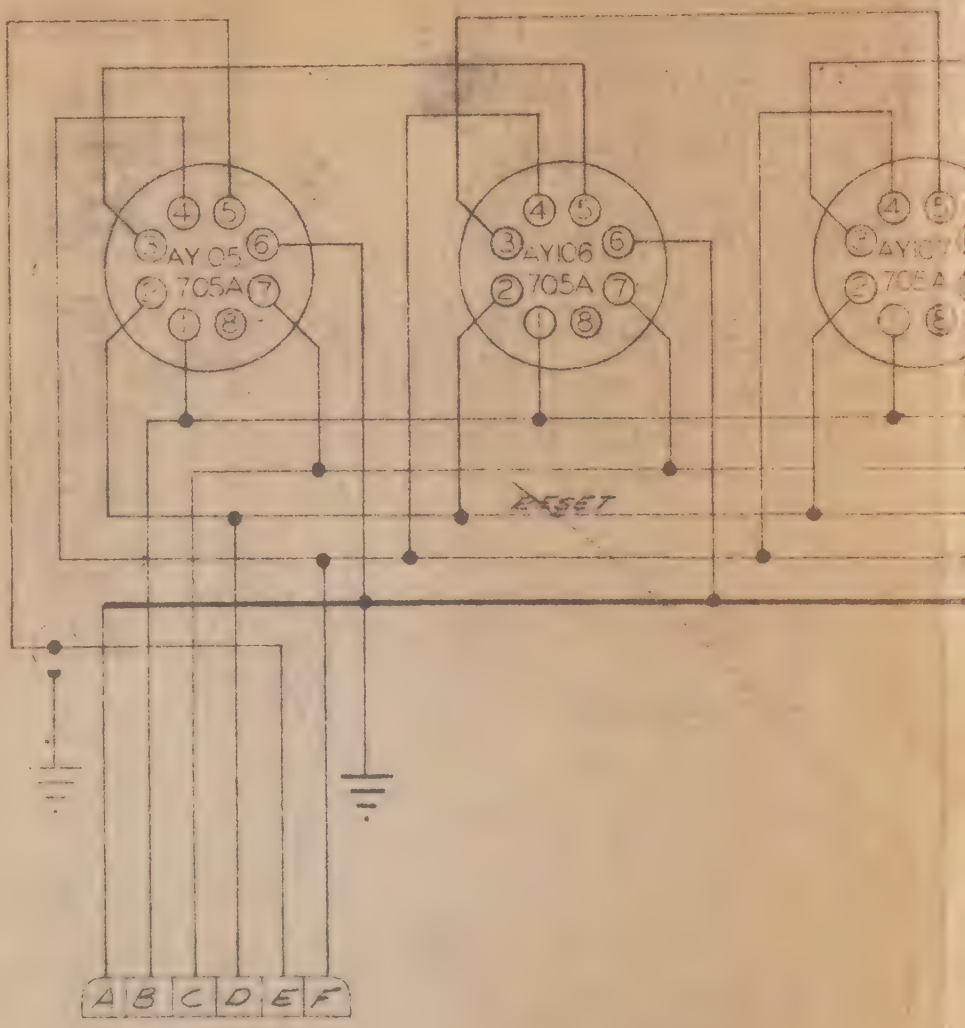
-250 V

NOTE:
RESISTORS: 1/2 W 5% UNLESS
OTHERWISE NOTED.

5601-50

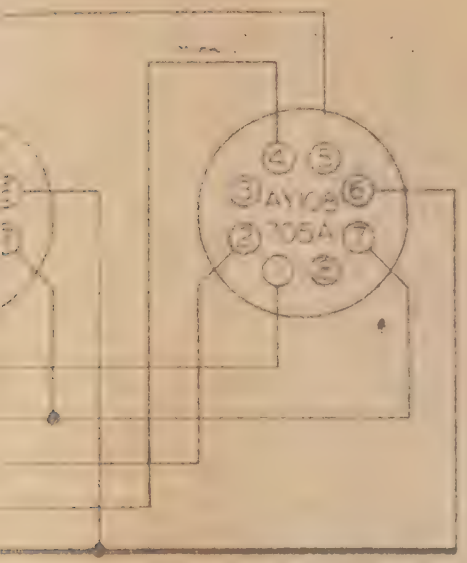
Berkeley Division BECKMAN INSTRUMENTS, INC.

CONTROL UNIT SCHEMATIC 20696 C 301 SA



P12
AN3106B-18-12P

REF.	QTY.	ZONE	DESCRIPTION	ECO No.	DATE	BY	CHK'D	APPD.



REF	STK OR DWG. No.	ITEM AND DESCRIPTION	QTY.

5210-3	
MODEL	NEXT ASSY
DRAWN	DATE 6-6-58
CHECKED	DATE
APPROVED	DATE
APPROVED	DATE

MATERIAL

FINISH

UNLESS SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES
FRACTIONAL ± 1/64
DECIMAL ± .005
ANGULAR ± 1°

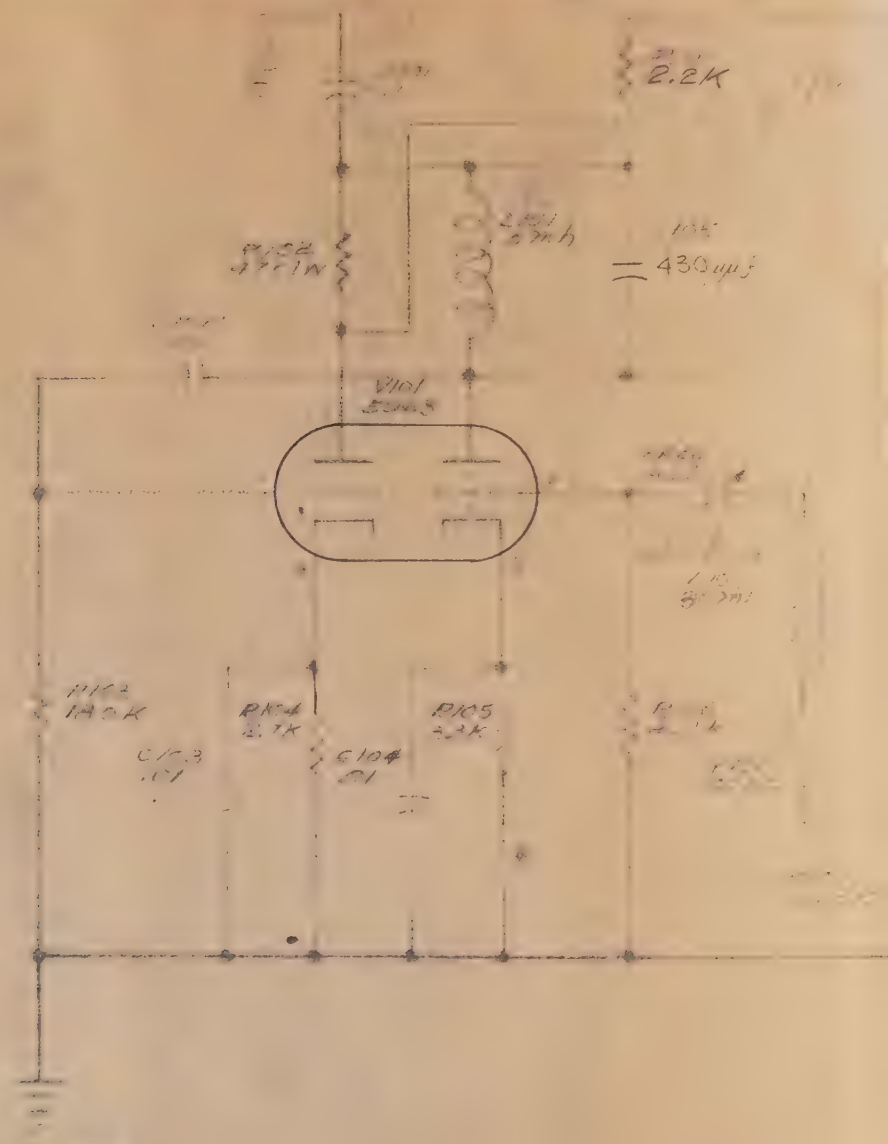
Berkeley division BECKMAN INSTRUMENTS, INC.

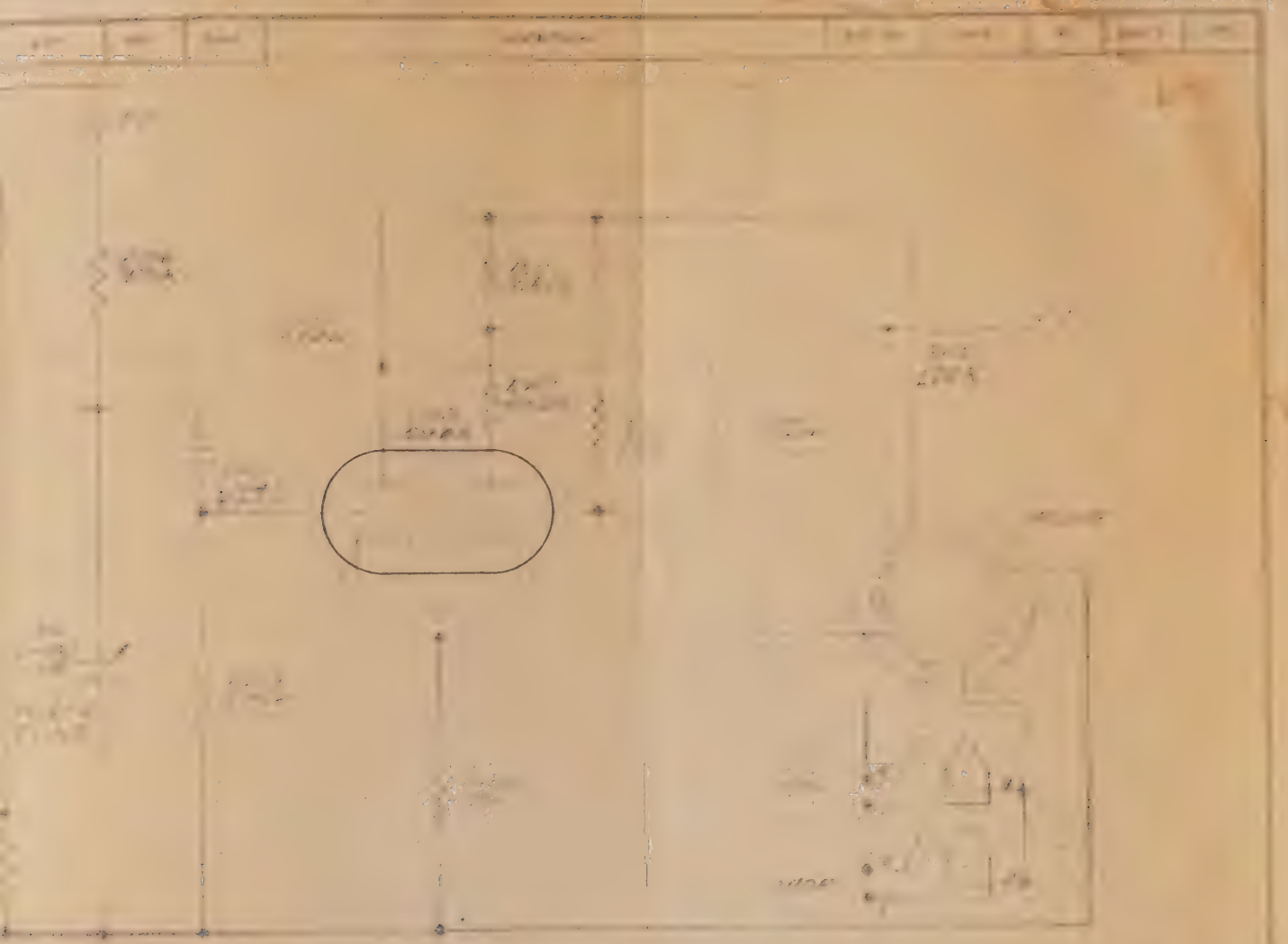
SCALE

TITLE READOUT UNIT SCHEMATIC

DRAWING No. 5210B03

REV.


2.2K
430 μμf
V101
6SN7
R102
150K
R104
2.7K
R105
2.2K
C103
.01
C104
.01



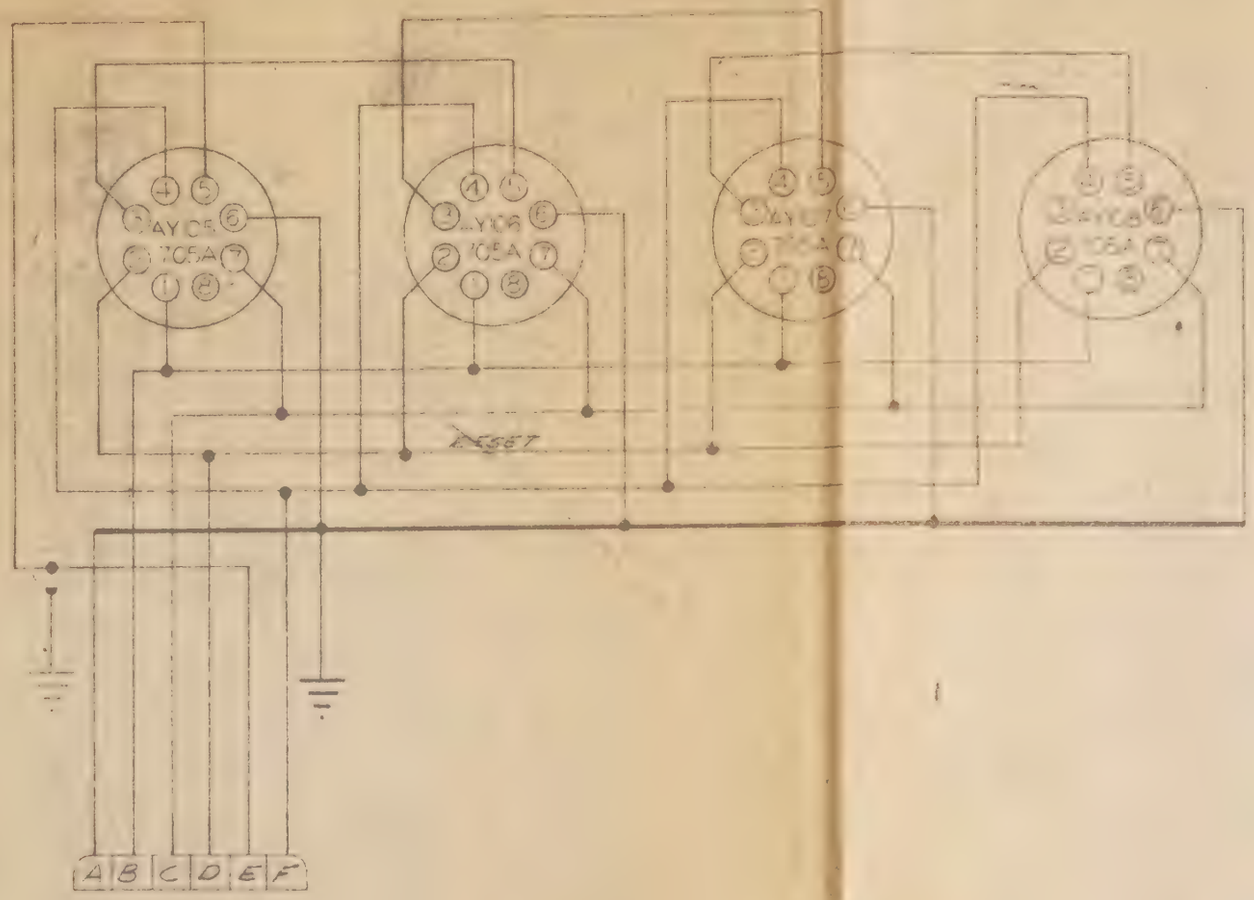
5632-3

Berkeley

SCHEMATIC

20,671 B303

SA



REF.	REV.	ZONE	DESCRIPTION	DATE	BY	CHK'D	APP'D

REF	STD. OR DWG. No.	ITEM AND DESCRIPTION	QTY

SR20-3	
WORK	NEXT ASSY
DRAWN	DATE 6-6-66
CHECKED	DATE
APPROVED	DATE
APPROVED	DATE

MATERIAL

FINISH

UNLESS SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES
FRACTIONAL ± 1/64
DECIMAL ± .005
ANGULAR ± 1/2°

Berkeley division BECKMAN INSTRUMENTS, INC.

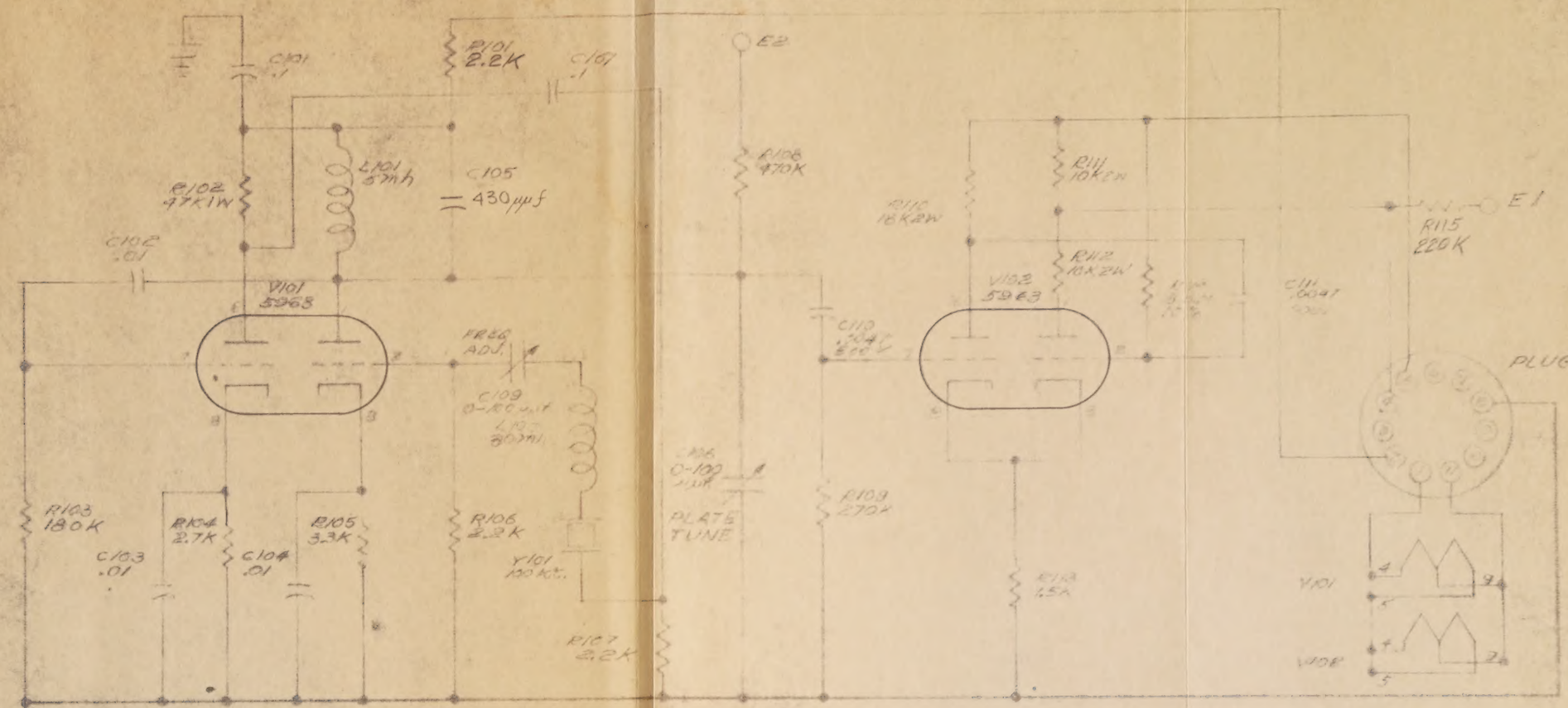
SCALE

TITLE READOUT UNIT SCHEMATIC

DRAWING No. S 3-19 B 23

REV

EFF.	REV.	ZONE	DESCRIPTION	ECO No.	DATE	BY	CHK'D	APP.



ALL RESISTORS ARE 1/2 W. ± 10 % UNLESS OTHERWISE NOTED.
ALL CAPACITOR VOLTAGE RATINGS ARE 600 V UNLESS OTHERWISE NOTED
ALL CAPACITOR VALUES ARE GIVEN IN mfd. UNLESS OTHERWISE NOTED

REF.	STK. OR DWG. No.	ITEM AND DESCRIPTION	QTY.

5632-3		MATERIAL
MODEL	NEXT ASSY.	FINISH
DRAWN BGM	DATE 9-14-60	Berkeley division BECKMAN INSTRUMENTS, INC.
CHECKED	DATE	UNLESS SPECIFIED: DIMENSIONS IN INCHES; TOLERANCES: FRACTIONAL ± 1/64, DECIMAL ± .005, ANGULAR ± ½°
APPROVED	DATE	SCALE
APPROVED	DATE	TITLE: OSC. & SHAPER SCHEMATIC
		DRAWING No. 20,696 B303
		REV. SA